we therefore do not estimate truck trips based on different employment classifications. Another reason for this is we don't have local survey data to support us to develop different trip rates for different employment types and conduct statistical test on whether different employment type has significantly different trip rate in North Carolina.

For the future, it is recommended that trip generation rates specific to North Carolina be developed by conducting a trip generation study in the state or by borrowing trip generation rates from other states similar to North Carolina.

Trip Distribution

Trip Distribution determines where the trips that are produced in the Trip Generation phase go. It "hooks-up" the trip productions in one TAZ with trip attractions in other TAZs. The gravity model is the most widely used trip distribution model. As its name suggests, the gravity model for transportation planning is based on Newton's gravitational theory. The gravity model predicts that the relative number of trips made between two geographic areas or TAZs, is directly proportional to the number of trip ends (productions and attractions) in each TAZ and inversely proportional to travel impedance (e.g., travel time and/or cost) between those two areas. Modern derivations of the gravity model illustrate that it can be motivated as the most likely spatial arrangement of trips given limited information available on zonal origin totals and constraints about mean trip lengths.

Two typical gravity models used for travel demand modeling are shown below:

$$T_{ij} = P_i \frac{A_j f(d_{ij})}{\sum_z A_z f(d_{iz})} \qquad T_{ij} = A_j \frac{P_i f(d_{ij})}{\sum_z P_z f(d_{zj})}$$

(Constrained to productions) (Constrained to attractions)

Where: T_{ij} = the forecast flow produced by zone *i* and attracted to zone *j*

P_i = the forecast number of trips produced by zone *i*

A_j = the forecast number of trips attracted to zone *j*

d_{ij} = the impedance between zone *i* and zone *j*

$f(d_{ij})$ = the friction factor between zone *i* and zone *j*

As these equations indicate, the gravity model can be singly-constrained to either productions or attractions or doubly-constrained to both productions and attractions. When the model is doubly-constrained, an iterative process is used that alternatively balances the productions from the first equation and then balance the attractions from the second equation. The doubly-constrained model conserves both the zonal productions and attractions. Preferred for the double-conservation ability, a doubly-constrained gravity model was developed in this study for distributing local truck trips.

As widely used in other travel demand models, the exponential function was chosen to compute O-D friction factors based on the travel impedance between each O-D pair. The friction factor has a form as shown below:

$$f(d_{ij}) = e^{-c(d_{ij})}$$

where, c is a parameter that needs to be calibrated in the model. The parameter, c, needs to be calibrated such that the model estimated trip length frequency distributions match the observed (or target) trip length